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ABSTRACT

This guide to teaching reading skills in the science classroom incorporates methods primarily associated with teaching reading as an isolated subject. Recommendations include determining the students' reading instructional level, matching text materials to that level, developing vocabulary through context clues and Latin and Greek roots, and developing main ideas through study outlines. (AEA)

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Skills and Techniques Useful In Developing Reading Abilities In Science

by

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Skills and Techniques Useful in Developing Reading Abilities in Science

Basically the teacher of science has two main problems:

1. to know the reading levels and range of the class
2. to know the readability level of the book

Teachers can use standardized test scores from the cumlative folders to determine the approximate reading level of the child. Most classrooms have a reading range which is equal to 2/3 of the chronological age. For example, if you were teaching a group of fifteen year olds, 2/3 of 15 is 10, therefore the reading level could range from 5 years above to 10 years below. In many chemistry and physics courses however, this will not be true. The range would automatically be reduced because many of the students are in a college preparatory tract. It is usually wise to consider that the test score from a standardized reading test is approximately a year higher than the level at which the child functions in the classroom. The standardized test score represents a frustrational level, one at which the child achieved by working very hard for a short time. The actual functioning level is usually approximately a year lower.

There are many ways to estimate the readabilty level of a book. In the afternoon session Mrs. Kasab will be demonstrating the Fry Readabilty Formula which will enable you to ascertain an approximate grade level of the book. There is a caution however, to be observed here. The readability level does not measure the difficulty of the concepts, or the style of writing. These two factors cannot be measured by the readability level but they do add to the difficulty and the complexity of the material.

The point thus far is of course to match the readabilty level of the book to the level of the class. If you have many students who are remedial readers and unable to read the book, it means that you must supplement it with easier

materials covering the same topics, and also do a great deal of oral discussion so that these students will get the information from an auditory input.

Why is reading in the sciences so much harder than in English and in Social Studies? English and Social Studies are about people, relate to people, and concern doings of people. They are much easier therefore to relate to than are sciences. In sciences we have a specialized and precise vocabulary, more abstract and difficult concepts, and lastly a very precise system of answering. In short, one cannot "fake it" in science or "talk around" it. It is either right or wrong.

I would like you to consider reading as part of a total language arts circle. The four spokes of the circle are reading, listening, writing and speaking. The reading and listening are receptive skills; the writing and speaking are expressive skills. Whenever we teach reading we have to lean on the other three spokes of that wheel to do the job in the reading field. Whenever we get off on a tangent and try to do reading without this, we will find ourselves in trouble. The four spokes of the wheel, the four skills, are connected to the hub, the center, which is vocabulary.

If one asked for a definition of reading, one might say it was getting meaning from the printed page. This is a perfectly acceptable definition. However, I would maintain that if you looked at the sentence, "School starts tomorrow!" and you contrasted two cases, the successful child verses the nunsuccessful child, although the words remain the same, the comprehension may be entirely different. This would be because they were bringing their past experience to the printed page. I would therefore posit to you that reading is not only getting meaning <u>from</u> the printed page, but reading is also bringing meaning <u>to</u> the printed page.

Comprehension is the goal of all reading and we'll find that the old question of whether comprehension is singular or global is still with us. The answer to this, researched by Dr. Davis of the University of Pennsylvania, has shown that he was able to isolate and measure the following four components of comprehension:

1. vocabulary
2. factoral or literal comprehension
3. getting the author's thought (main idea-concepts)
4. ability to organize material (outline)

Since we know that these are components of comprehension we should therefore teach them.

Vocabulary

Vocabulary should always be taught orally first because this is the way language is acquired. The teacher should use the new words in a motivating sentence which is a preview of the coming chapter. Secondly, vocabulary can be taught by context clues. Many teachers tell students to use context clues but few show them how to do it. I would give sentences to the students using context clues in the following ways:

1. by definition
2. by contrast
3. by example
4. by analogies
5. by the tone of the total paragraph

Use your words in context clues by each of these five different methods and it will help you very much in illustrating to the students how context clues can be gained from the text itself. Learning vocabulary should not be mere memorization which will be learned and forgotten, but a transfer of learning by application.

Another way to increase vocabulary very rapidly is by the use Latin and Greek roots. In one science textbook I counted 90 words which were based on the word meter. There are many other examples of how the use of one word can be applied and expanded to improve your vocabulary. Learning the Latin and Greek roots for words and numbers are very helpful: mono, bi, di, tri, quad, tetra, quint, pent sex, sep, etc..

Teachers should avoid the assignment of Latin and Greek roots to be memorized. A more useful manner would be to give the student a silly paragraph such as the following:

Fred donned his aqua colored swimming trunks, strapped his aqua lung to his back, picked up his aqua spear, hopped over the aqueduct into the aquarium, in search of aquatic plants.

At the end of that sentence the student is bound to get a glimmer that aqua relates to water.

It has been estimated that learning fourteen different words with different Latin and Greek roots can increase one's vocabulary by about fourteen thousand words. The following list of words contains twelve Latin roots, two Greek roots, and twenty most important prefixes.

precept	epilogue
detain	aspect
intermittent	uncomplicated
offer	nonextended
insist	reproduction
monograph	indisposed
	oversufficient
	mistranscribe

Learning and applying these basic roots and prefixes is a very rapid way to extend vocabulary.

Teachers in the science field deal with three types of vocabulary:

1. general vocabulary - These are regular words used in daily speech and cause no problem.

2. technical terms - These words are used specifically in your area and you will have to teach these with a specific science definition.

3. specialized vocabulary - These words are commonly known but also have a very specific definition when used in your field. These words cause considerable difficutly.
   Ex.: radical - as in math
   element - as in chemistry
   properties - as in chemistry
   compound - as in chemistry
   stereo - as in chemistry

In teaching reading in the science field we should also be sure to help students notice special words that are signal words. Some words indicate that the same line of thought is being continued by the author: also, moreover, indeed, furthermore.

Some words signal that the idea is changing: but, however, yet, despite, on the contrary.

Some words signal a tentative solution or conditional situation: provided that, if, unless, whenever.

Some words indicate time changes: earlier, formerly, subsequently.

Other words indicate contrast: inversely, whereas, on the other hand.

Of course, the common words for summary are well known: thus, in summary, in short, therefore.

It is most important that we use the new vocabulary words, that we have students hear them, speak them, read them, and then write them. It is the appeal to all modalities which is most effective.

Concepts

We have to be very careful that children get a complete concept of the ideas in science. It is very easy to assume that they can memorize, and verbalize. If the student can tell the idea in his own words, he probably knows it. If he can use the idea and apply it in a new situation I am sure he knows it. We have to bridge the gap between the known and the unknown and integrate the new concepts with what he already knows. Science teachers should ask themselves a few questions. What concepts are really significant and worth teaching? Why is this so? Can I justify this to myself? If we cannot do so, we should reconsider this unit.

In trying to develop a concept of something, one might ask a child, "What is an orange?" If the child replies it is round, he is giving a description. If he says it can be eaten, he is giving a function. If he says it's a fruit, he has put it into a category. All of these three, the description - the function - the

category, are needed to have a complete concept of the orange.

It is also necessary to provide negative examples, for without those the child has nothing to compare it with. Frequently the reader and the writer get different concepts of the material because the child fails to see the total function of the word.

Most children learn on three basic levels of learning. The first is called the sensory level or concrete level. At this stage the child learns through the concrete senses. Secondly, he moves up to a verbal level in which hearing and saying the words takes over for the concrete experience. Thirdly, he learns to read and write the words and this graphic area takes over for all the others. It is obvious that the whole process of learning to read is based on his previous total language experience and his previous total experience.

Whenever we are having difficulty in the reading field we should return to that Level 1, sensory concrete experience. The science field is ideal for this because you can do experiments with 'hands on' type of activity, down at the concrete sensory level.

One of the concepts which is most difficult to obtain for children is the sense of chronology or time. Piaget has said that the children do not really acquire a good sense of time until they are about 11 or 12. The social studies teacher has long taken the abstract concept of time and made it graphic by plotting it on a time line. This takes the abstract concept and makes it concrete.

Another of the helpful things in reading science is to realize that the questions you ask will have a lot to do with the kinds of thinking the children do The kinds of thinking they do will effect the kinds of discussion that you have in your classroom. If your questions stay on the factual level and do not get into the inference and critical level, you can only expect their thinking to stay on the rote level and never rise higher. If the thinking stays on that level, the discussion will probably stay on that level. If however you raise your level of

questioning, it will effect and improve the thinking, and the thinking will effect and improve the discussion. If the discussion is really good, it will raise further questions which will drive the students back to the books for answers.

Be careful to,that your remedial reader is not looking to find the answers for critical and inferential questions as a verbatim item in the text. Help him to see the difference between these two kinds of questions.

There has been ample research to show that teachers usually allow only three seconds for student to answer. Give the child time to think before he answers. If we immediately call on someone else or supply the answer, we deny the child this opportunity. If we allow as much as a minute or two minutes, the percentage of right answers will increase rapidly.

Memory

The whole purpose of reading is to get a body of knowledge and to be able to remember it. Students need help remembering what they have learned. Research shows us that we have a short term memory lasting perhaps a quarter of a second, and a long term memory. If the short term memory gets overloaded, the information is either put into the long term memory or forgotten. Our physical senses admit the information into the brain. The brain registers it, stores it, and retrieves it. We might think of it in terms of input, storage, and retrieval.

There is concrete evidence that memory is improved when the input is interesting or dramatic. We all tend to remember the most pleasant and the most dire events. Input is also improved if there is a pattern to content of the material. If the pattern is already present it is easier; if the child must derive that pattern, it is more difficult. We know that the pattern recognition process is a selective thing, depending highly on experience. Since the student is constantly making selections and decisions in learning it is helpful to him to have patterns to relate to.

Organization of Material

One of the most helpful skills you can teach your students in reading science

materials, is the ability to read a chapter and to be able to express the main idea or ideas in their own words. This is helpful because it organizes the information into a structure and thus helps them to remember it better. Many teachers tell students to give them the main idea when the main idea is not stated verbatim in the text. Frequently the student has to assimilate all of the materials and then express it in his own words. Don't tell the students to do it - show them how.

I would do this by using science material on approximately one year level below their present reading textbook. The teacher should select a small portion of the material, perhaps two or three sections, and read it through first himself. Then write out on a piece of paper and give to the students three possible expressions of the main idea. The first one is what I call my "way out" idea. It has absolutely nothing to do with the text. The second statement is a poor expression of the main idea and the third statement is a good expression of the main idea. When the students are faced with the three options they will immediately eliminate number one, leaving the poor and good expression. If they choose the poor expression you have to show them why it is a poorer expression of the main idea. This could be because it is too detailed, because it has incorrect information, or because it does not cover the main points. After they see why your third idea is the best, repeat this same procedure alternating the different types of statements until they can grasp the idea quickly.

Then raise the level of this learning; try it again with three statements but eliminate the "way out idea," and present to them three statements, one of which is a poor expression, a better expression, and a good expression of the main idea. Again explain to them why each one is better than the other. When they can do this well, proceed to the third step in the strategy by having them read the selection and compose their own concept of the main idea. This is an infinitely better way to teach students how to get the main idea then it is just to tell them to do it.

Study Outline

If you examined your undergraduate texts you would probably find that many, many sentences on a page were underlined. The reason for this is that you were unable

to distinguish between the main ideas and the supporting details. If you can teach your students how to make a good study outline, it will be an infinite help to them in organizing and retaining the information they are trying to learn. Again I would select material that was at least a grade lower than the present selection they are working on. This will eliminate or reduce the problem of vocabulary difficulty and concept difficulty and enable them to concentrate on the outline itself.

I would start by presenting them with a written statement of the main ideas expressed in the outline. For example, I, II and III. Under each of the Roman Numerals I would enumerate the number of facts which are necessary to support that main idea. For example, Roman Numeral I would express your main idea and underneath that would be an A with a question mark and the student would have to fill in the one supporting detail. The second main idea may have two supporting details. The third main idea may have three, so you give the student the main idea; he fills in the supporting details. After you have done this several times you are ready to raise the learning strategy and continue.

In the new section of the strategy you would present the student with the statement of the supporting details and then ask them to express the main idea. In other words you have reversed the process. You started by giving them the main ideas and having them supply the details, going from the general to the specific and now you have reversed that process. I would do this several times until they were finally able to compose a study outline which would be useful to them in recalling the information.

Do not confuse this with the old concept of the English teacher's outline in which, if you had a A, you must have a B, because you could not divide something into one piece. Many times there is only one supporting detail; there are not two.

Directed Reading Activity

Another very helpful activity for you to conduct when you are helping your students to read science material is what a reading teacher would call a Directed

Reading Activity. This strategy involves the following steps. Firstly, motivate the class to read the selection by telling them why they are reading it, setting a purpose for reading it - what they are reading to find, and relating it to the past chapters and past information. This again underlines the thought that comprehension is always relating the new to the old. I would use the new and difficult hard words in context in my motivation.

Secondly, we would read the selection silently to give people a chance to find the answers to the questions or to the task you had set for the silent reading. Thirdly, we would discuss the questions to see if the students had found those. In the discussion new questions usually arise and these provide a reason for rereading sections orally. During this time the students who are poor readers are able to get much of the information from the auditory input. And finally we would help them organize material into a series of main ideas or a good study outline as has been previously discussed.

Always remember again,in comprehension that you will learn and remember the material better when it is connected or related to something you already know. Dr. David Ausabel, a prominent learning theorist, has stated that knowledge is organized in heirarchy from general concepts to specific facts. One very good strategy for helping students to again read the material and organize it in their thinking is to present them first with what reading people call "advanced organizers." Advanced organizers give a structured overview which simply tells the student the main idea that he is expected to get from reading the selection. These again may be stated as full statements, in an outline, in a diagram as in evaporation and water cycle, or in a flow chart as in the process of photosynthesis. Advanced organizers again relate what is coming to what has been and help the student with his comprehension.

Structure of a Paragraph

The structure of a paragraph is very helpful if you teach your students not only the total pattern of organization of the whole text but to look at the pattern of organization of separate paragraphs. Many paragraphs are organized in a helpful

way and the students recognize this. It shows them the important parts and separates the main ideas from the details.

Paragraphs may be organized with a topic sentence followed by details, or in the reverse procedure, the details followed by a topic sentence. Often a question is asked and the following paragraph gives the answers. Sometimes a comparison or analogy is set up and if the student knows one part of the analogy he can figure out the second part. Frequently chemistry experiments are set up sequentially. It is important that the student realize that the sequence is given for special reasons and to realize that one item follows the next.

Some paragraphs may state or ask a problem and the remainder of the paragraph is devoted to steps in the solution. Other paragraphs list or are organized in terms of cause leading to effect. Sometimes whole sections of material will be giving examples, and it is not necessary for the student to learn every example, but rather the general principle.

Be careful that students do not confuse the topic sentence with the main idea. The topic sentence tells what the paragraph is going to be about, whereas the main idea tells what it is.

The style of writing of the author often causes confusion in comprehension. If a noun is separated from the verb by many other words, it is often difficult for the student to connect the two together. Authors frequently use pronouns which refer back to something that is ambiguous or unclear. Referential cohesion or the meaning of the referent can be a noun, a phrase or clause, and sometimes the whole tone of a section. Helping students to find the referent for the pronoun is frequently very helpful.

Improving Assignments

When we give assignments to a student we should remember three important things.

1. Why should he do it. (motivation)
2. What should he do. (content)
3. How he should do it. (skills)

The teacher should make it very clear what the pupil is expected to do and to produce as a result of the work, if the output is to be oral, written, or whatever. Telling the pupil ahead of time and indicating clearly what kind of recall is expected is extremely helpful. Some students will perform well verbally, others in a written fashion, and for others they may have difficulty in both. Assigning a student to read the following chapter is often considered a cardinal sin in the reading field. This is simply because it is the teacher's motivation and it gives no concern for the student's motivation. A good assignment therefore should explain not only the what, why, and how the assignment is to be done, but should relate it to the previous assignment and indicate to the student what he will do with the material when he has learned it.

Summary

To recapitulate some of the main points I have made here I would suggest that we try to remember the following. I have stated that we need to know the reading instructional level of the students in the class and expect that there will be a range. We will have to supplement the required text with easier material and with much oral discussion to help the remedial reader. We should also know the level of the text and try to match the textbook to the students' reading levels.

Giving concern to the particular concepts we are trying to teach is very significant. We should know what we're trying to teach, how we can develop those concepts and then how we can remember them. If we cannot justify to ourselves the "why?" of the work, we should rethink it in our own minds. Remember too, the definition of reading is not only getting meaning from the printed page but bringing meaning to the printed page.

I have stressed the importance of developing vocabulary through context clues, Latin and Greek roots and using these in as many ways as possible to appeal to both the auditory and visual modalities. I have discussed the idea of developing total concepts rather than memorizing facts. One main idea of this presentation has been that the teaching of how to develop or how to generate main ideas and

generate study outlines is an effective way of improving comprehension.

The hen and the pig were having a philosophical discussion in the barnyard as to how they could help mankind. Finally the hen announced that she thought they should provide ham and eggs to mankind. The pig thought for a moment and then said, "For you this would be a contribution; for me it would be a total committment." I think we're asking you for a total committment!

I can recall learning the 102 bones of the body in a biology class, but as an educator I have found that I have need for only three: a backbone for stamina, a wishbone for inspiration, and a funny bone for survival.